Physicsaholics

DPP – 6 (SHM)

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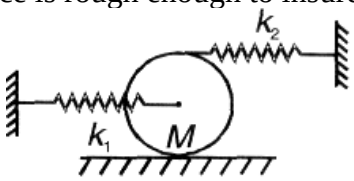
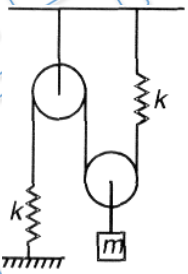
Q 1. A disc of mass M is connected to two springs k_1 and k_2 as shown find. time period of small oscillations if surface is rough enough to insure rolling



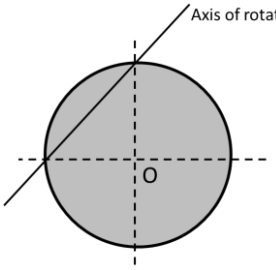
(a) $2\pi\sqrt{\frac{2m}{k_1+4k_2}}$ (b) $2\pi\sqrt{\frac{m}{k_1+4k_2}}$ (c) $2\pi\sqrt{\frac{3m}{2(k_1+4k_2)}}$ (d) $2\pi\sqrt{\frac{2m}{3(k_1+2k_2)}}$

Q 2. Find time period of oscillation for arrangement shown in figure. All pulleys, strings and springs are massless.



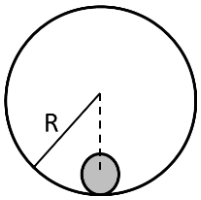
(a) $2\pi\sqrt{\frac{m}{2k}}$ (b) $2\pi\sqrt{\frac{2m}{k}}$ (c) $2\pi\sqrt{\frac{m}{3k}}$ (d) $\pi\sqrt{\frac{m}{2k}}$

Q 3. A uniform disc of mass m and radius R is executing angular s.h.m. about an axis inclined at angle π/4 with vertical. Time period of disc is



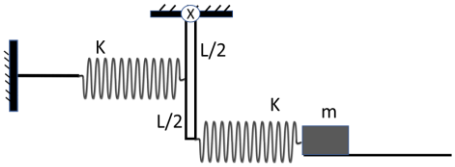
(a) $2\pi\sqrt{\frac{3R}{2g}}$ (b) $2\pi\sqrt{\frac{2R}{3g}}$ (c) $2\pi\sqrt{\frac{R}{2g}}$ (d) $2\pi\sqrt{\frac{3R}{g}}$

Q 4. A uniform solid sphere of mass m and radius r was resting at bottom of highly rough cylindrical surface as shown in figure. Sphere is slightly displaced and released. Time period of its motion is



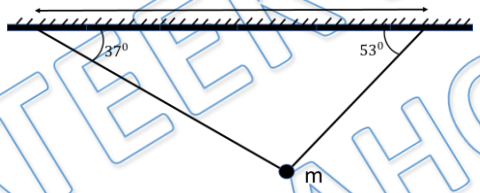
(a) $2\pi\sqrt{\frac{7(R-r)}{5g}}$ (b) $2\pi\sqrt{\frac{3(R-r)}{5g}}$ (c) $2\pi\sqrt{\frac{2(R-r)}{5g}}$ (d) $2\pi\sqrt{\frac{7R}{5g}}$

Q 5. In given figure rod is massless and in vertical position of rod springs are in natural length and block is placed on smooth surface. Time period of oscillation of block is



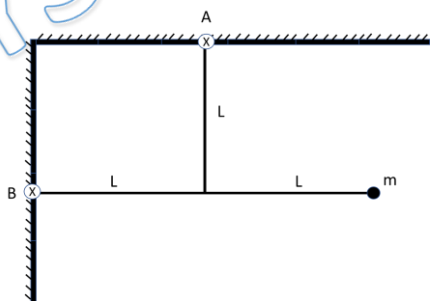
(a) $2\pi\sqrt{\frac{m}{5k}}$ (b) $2\pi\sqrt{\frac{5m}{k}}$ (c) $2\pi\sqrt{\frac{2m}{5k}}$ (d) $2\pi\sqrt{\frac{3m}{5k}}$

Q 6. A bob is hanging with the help of two massless strings as shown in figure. Find time period of small oscillations of bob?



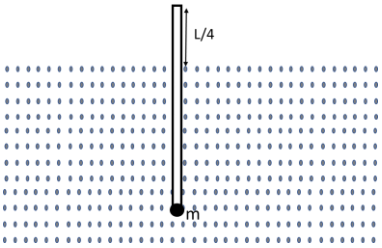
(a) $2\pi\sqrt{\frac{3l}{4g}}$ (b) $2\pi\sqrt{\frac{3l}{5g}}$ (c) $2\pi\sqrt{\frac{12l}{25g}}$ (d) $2\pi\sqrt{\frac{l}{g}}$

Q 7. In given figure rods are massless and pivoted at points A and B. Find time period of small oscillations of system?



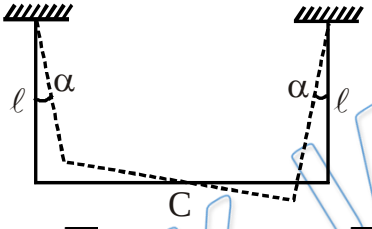
(a) $2\pi\sqrt{\frac{L}{g}}$ (b) $2\pi\sqrt{\frac{2L}{g}}$ (c) $2\pi\sqrt{\frac{L}{2g}}$ (d) $2\pi\sqrt{\sqrt{2}\frac{L}{g}}$

Q 8. A particle of mass m is attached with uniform rod of mass m and length L and system is floating in water as shown in figure. Now rod is slightly turned from vertical position and released. Find time period of angular shm of rod?



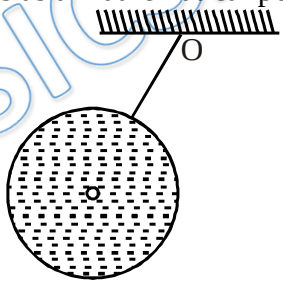
(a) $2\pi\sqrt{\frac{2L}{g}}$ (b) $2\pi\sqrt{\frac{6L}{5g}}$ (c) $2\pi\sqrt{\frac{L}{g}}$ (d) $2\pi\sqrt{\frac{5L}{6g}}$

Q 9. A uniform rod of mass m and length l suspended by two identical threads l in length was turned through a small angle about the vertical axis passing through its middle point C. The threads deviated in the process through a small angle. Then the rod was released to start performing small oscillations. Time period of rod is



(a) $2\pi\sqrt{\frac{l}{4g}}$ (b) $2\pi\sqrt{\frac{l}{3g}}$ (c) $2\pi\sqrt{\frac{2l}{3g}}$ (d) $2\pi\sqrt{\frac{4l}{3g}}$

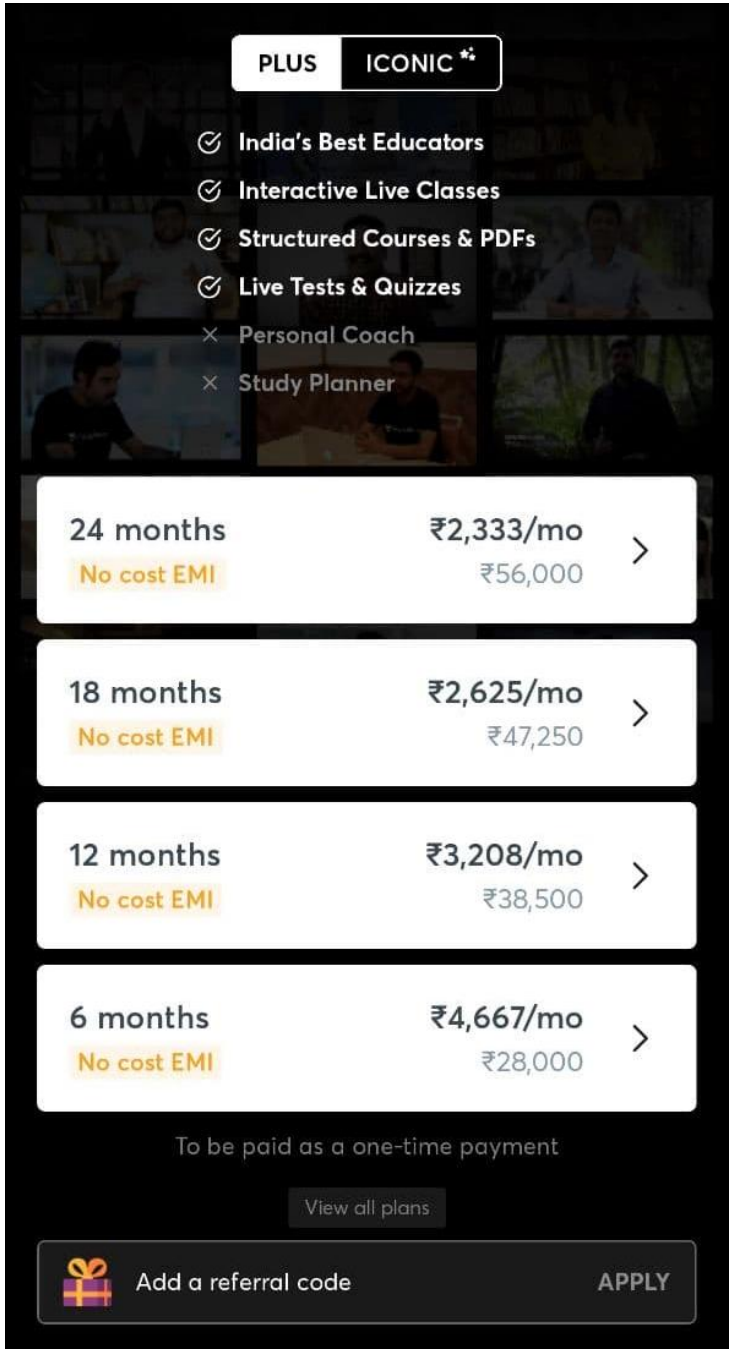
Q 10. A pendulum is constructed as a light thin-walled sphere of radius R filled up with water and suspended at the point O from a light rigid rod. The distance between the point O and the centre of the sphere is equal to l. How many times will the small oscillations of such a pendulum increase after the water freezes? The viscosity of water and the change of its volume on freezing are to be neglected. moves translation wise, and the system behaves as a mathematical pendulum.



(a) $\sqrt{1+\frac{1}{5}\left(\frac{R}{\ell}\right)^2}$ (b) $\sqrt{1+\frac{2}{5}\left(\frac{R}{\ell}\right)^2}$ (c) $\sqrt{1+\frac{2}{3}\left(\frac{R}{\ell}\right)^2}$ (d) 1

Answer Key

Q.1 c	**Q.2 a**	**Q.3 a**	**Q.4 a**	**Q.5 b**
Q.6 c	**Q.7 b**	**Q.8 d**	**Q.9 b**	**Q.10 b**



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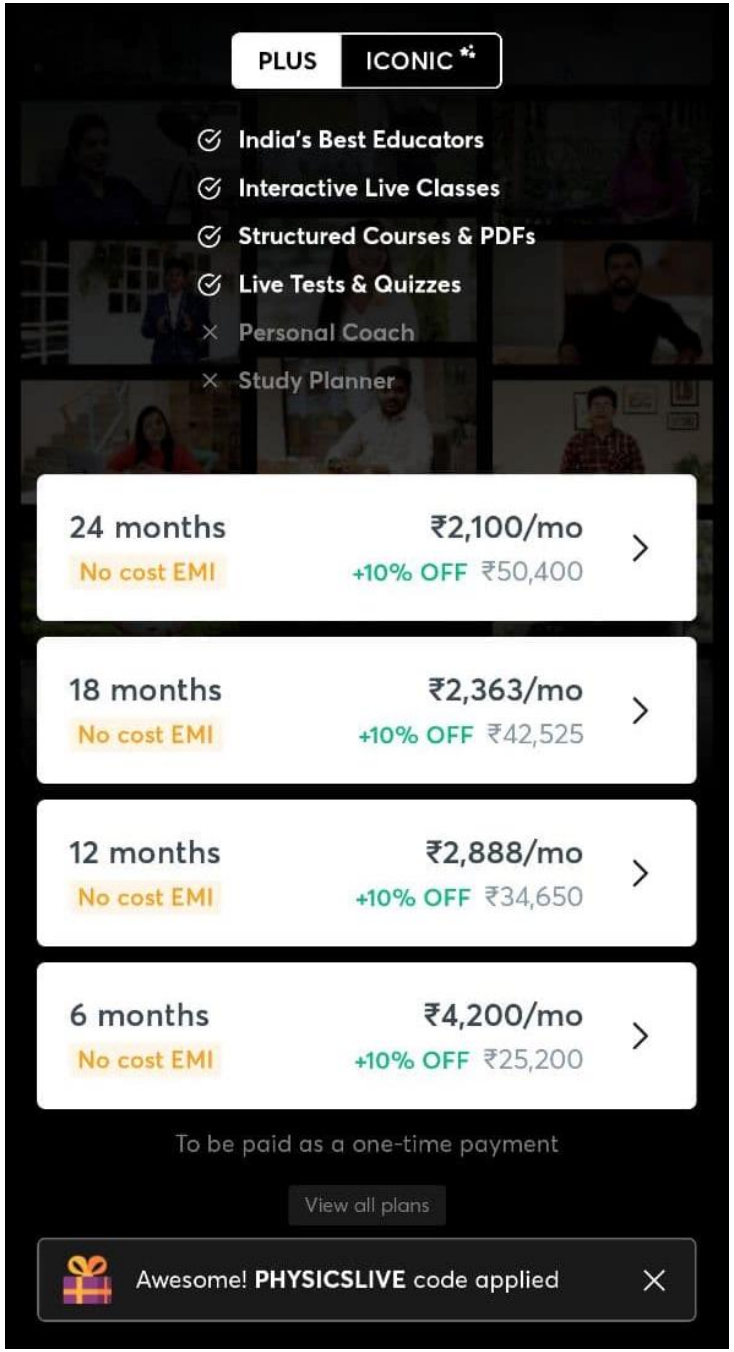


JEE Main & Advanced, NSEP, INPhO, IPhO
Physics DPP- Solution

DPP- 6 S.H.M. : Special Problems For JEE Advance

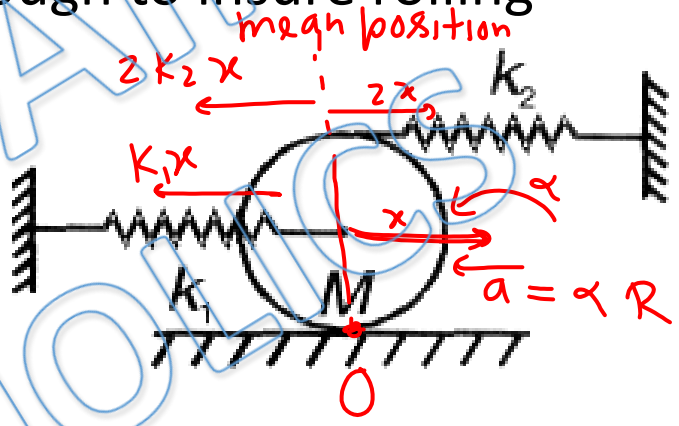
By Physicsaholics Team

Q1) A disc of mass M is connected to two springs k_1 and k_2 as shown find. time period of small oscillations if surface is rough enough to insure rolling

$\tau = I\alpha$

$k_1 x R + 2k_2 x 2R = \frac{3}{2} m R^2 \alpha$

$(k_1 + 4k_2)x = \frac{3m}{2} a$



(a) $2\pi\sqrt{\frac{2m}{k_1+4k_2}}$ (b) $2\pi\sqrt{\frac{m}{k_1+4k_2}}$

$a = \frac{2(k_1+4k_2)}{3m} x$

(c) $2\pi\sqrt{\frac{3m}{2(k_1+4k_2)}}$ (d) $2\pi\sqrt{\frac{2m}{3(k_1+2k_2)}}$

Q2) Find time period of oscillation for arrangement shown in figure. All pulleys, strings and springs are massless.

(a) $2\pi\sqrt{\frac{m}{2k}}$

(b) $2\pi\sqrt{\frac{2m}{k}}$

(c) $2\pi\sqrt{\frac{m}{3k}}$

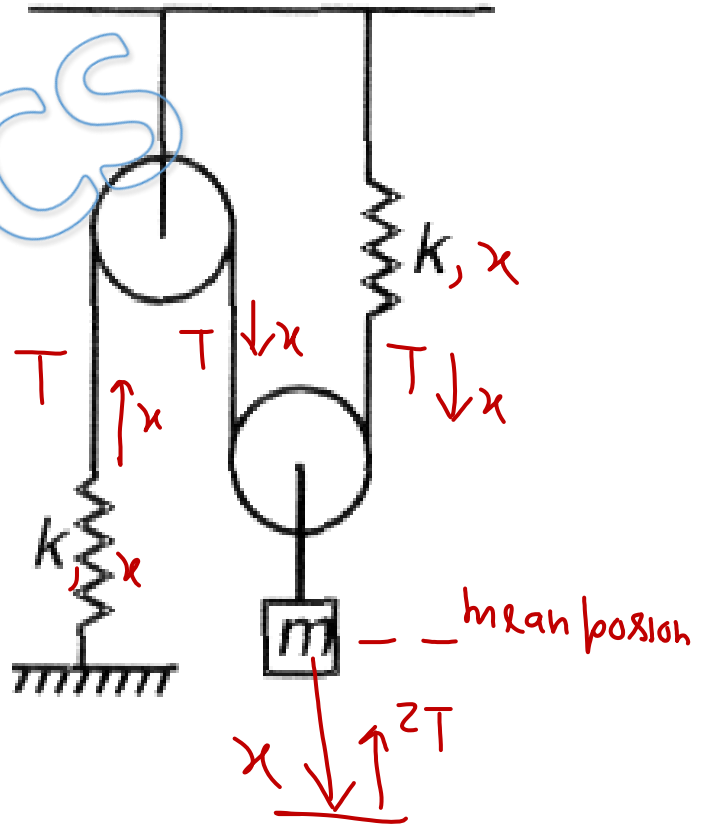
(d) $\pi\sqrt{\frac{m}{2k}}$

$T = Kx$

acceleration of block $= \frac{2T}{m}$

$a = \frac{2Kx}{m}$

$T = 2\pi\sqrt{\frac{m}{2K}}$



Q3) A uniform disc of mass m and radius R is executing angular s.h.m. about an axis inclined at angle π/4 with vertical. Time period of disc is

$T = 2\pi\sqrt{\frac{I}{m g_{eff} l}}$

$= 2\pi\sqrt{\frac{\frac{mR^2}{4} + m\left(\frac{R}{\sqrt{2}}\right)^2}{m\frac{g}{\sqrt{2}} \times \frac{R}{\sqrt{2}}}}$ $g_{eff} = g/\sqrt{2}$

$= 2\pi\sqrt{\frac{\frac{3}{4}mR^2}{mgR/2}}$

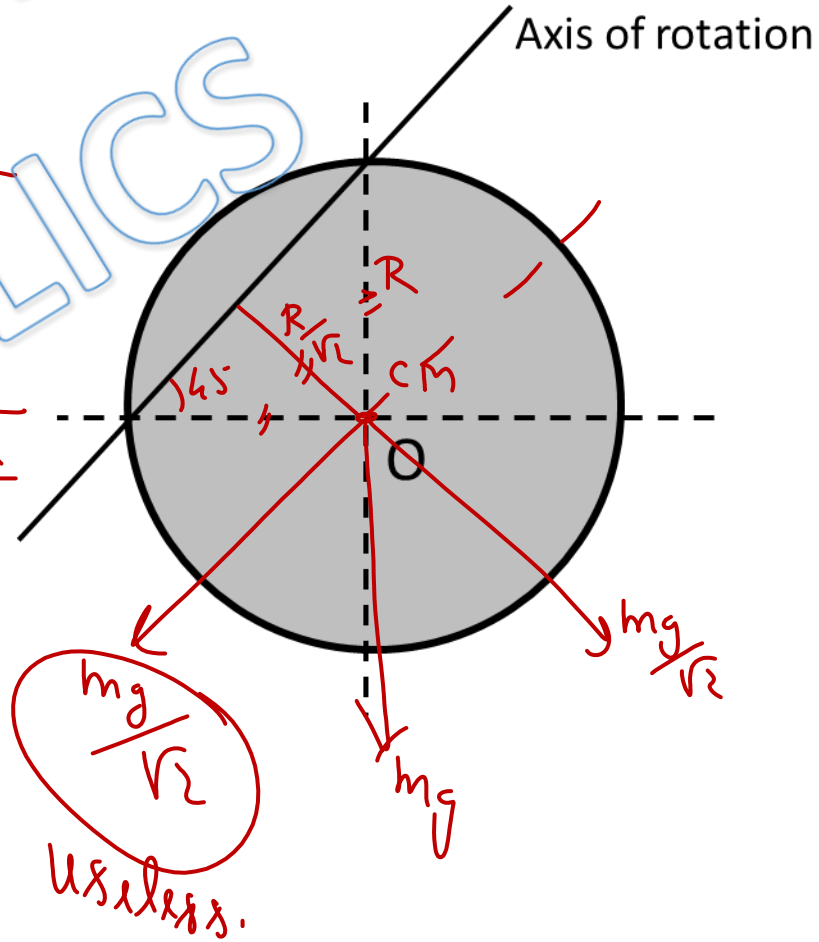
$= 2\pi\sqrt{\frac{3R}{2g}}$

(a) $2\pi\sqrt{\frac{3R}{2g}}$

(b) $2\pi\sqrt{\frac{2R}{3g}}$

(c) $2\pi\sqrt{\frac{R}{2g}}$

(d) $2\pi\sqrt{\frac{3R}{g}}$



Q4) A uniform solid sphere of mass m and radius r was resting at bottom of highly rough cylindrical surface as shown in figure. Sphere is slightly displaced and released. Time period of its motion is

$\tau_o = I_o\alpha \Rightarrow mg\sin\theta\, r = \frac{7}{5}mr^2\alpha$

$a = \frac{5}{7}g\sin\theta$

$a = \frac{5g}{7}\theta$

$a = \frac{5g}{7(R-r)}x$

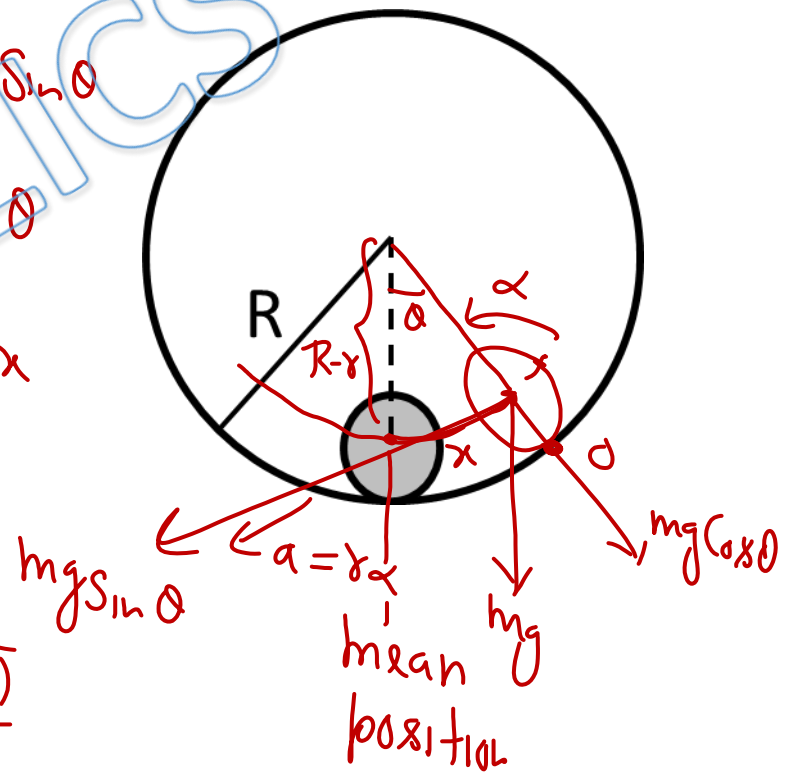
(a) $2\pi\sqrt{\frac{7(R-r)}{5g}}$

(b) $2\pi\sqrt{\frac{3(R-r)}{5g}}$

(c) $2\pi\sqrt{\frac{2(R-r)}{5g}}$

(d) $2\pi\sqrt{\frac{7R}{5g}}$

$T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$



Q5) In given figure rod is massless and in vertical position of rod springs are in natural length and block is placed on smooth surface. Time period of oscillation of block is

net torque on massless rod = 0

$\frac{KL}{2}\theta \frac{L}{2} = K(x-L\theta)\frac{L}{2}$

$\frac{L\theta}{4} = x - L\theta$

$x = \frac{5L\theta}{4}$

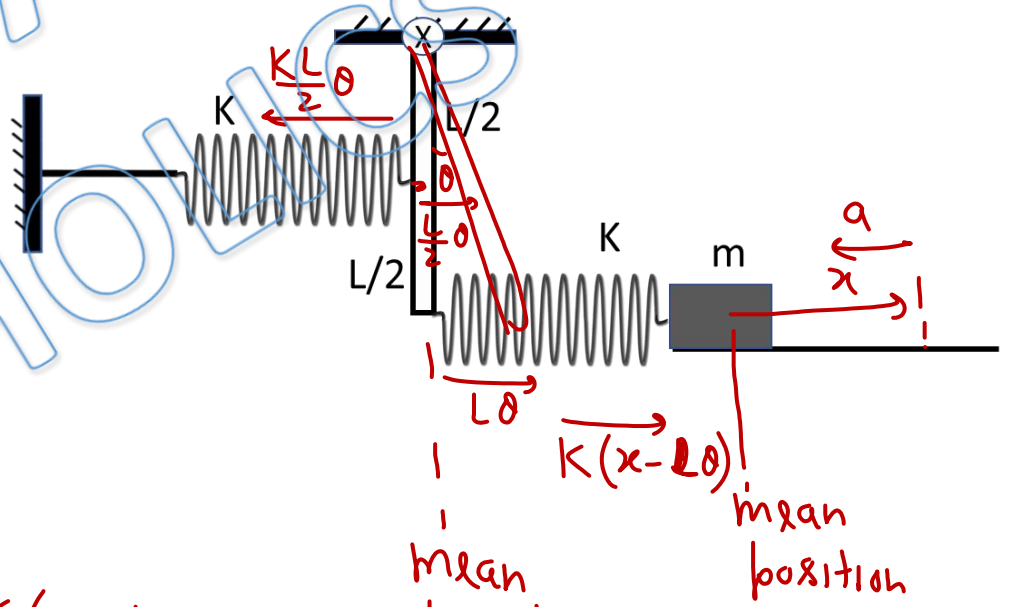
$L\theta = \frac{4x}{5}$

(a) $2\pi\sqrt{\frac{m}{5k}}$

(b) $2\pi\sqrt{\frac{5m}{k}}$

(c) $2\pi\sqrt{\frac{2m}{5k}}$

(d) $2\pi\sqrt{\frac{3m}{5k}}$

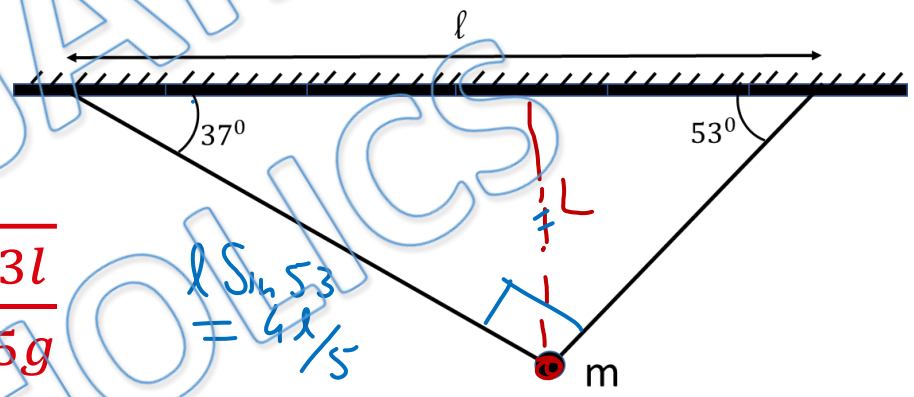


acceleration of block $= \frac{K(x-L\theta)}{m}$

$a = \frac{K}{m}\left(x - \frac{4x}{5}\right) = \frac{Kx}{5m} \Rightarrow T = 2\pi\sqrt{\frac{5m}{K}}$

Q6) A bob is hanging with the help of two massless strings as shown in figure. Find time period of small oscillations of bob?

$T = 2\pi\sqrt{\frac{I}{mgl}}$



(a) $2\pi\sqrt{\frac{3l}{4g}}$

$T = 2\pi\sqrt{\frac{mL^2}{mgL}}$

$= 2\pi\sqrt{\frac{L}{g}}$

(b) $2\pi\sqrt{\frac{3l}{5g}}$

$l\sin 53 = 4l/5$

(c) $2\pi\sqrt{\frac{12l}{25g}}$

$= 2\pi\sqrt{\frac{12l}{25g}}$

(d) $2\pi\sqrt{\frac{l}{g}}$

$L = \frac{4l}{5}\sin 37^\circ$

$= \frac{4l}{5} \times \frac{3}{5}$

$= \frac{12l}{25}$

Q7) In given figure rods are massless and pivoted at points A and B. Find time period of small oscillations of system?

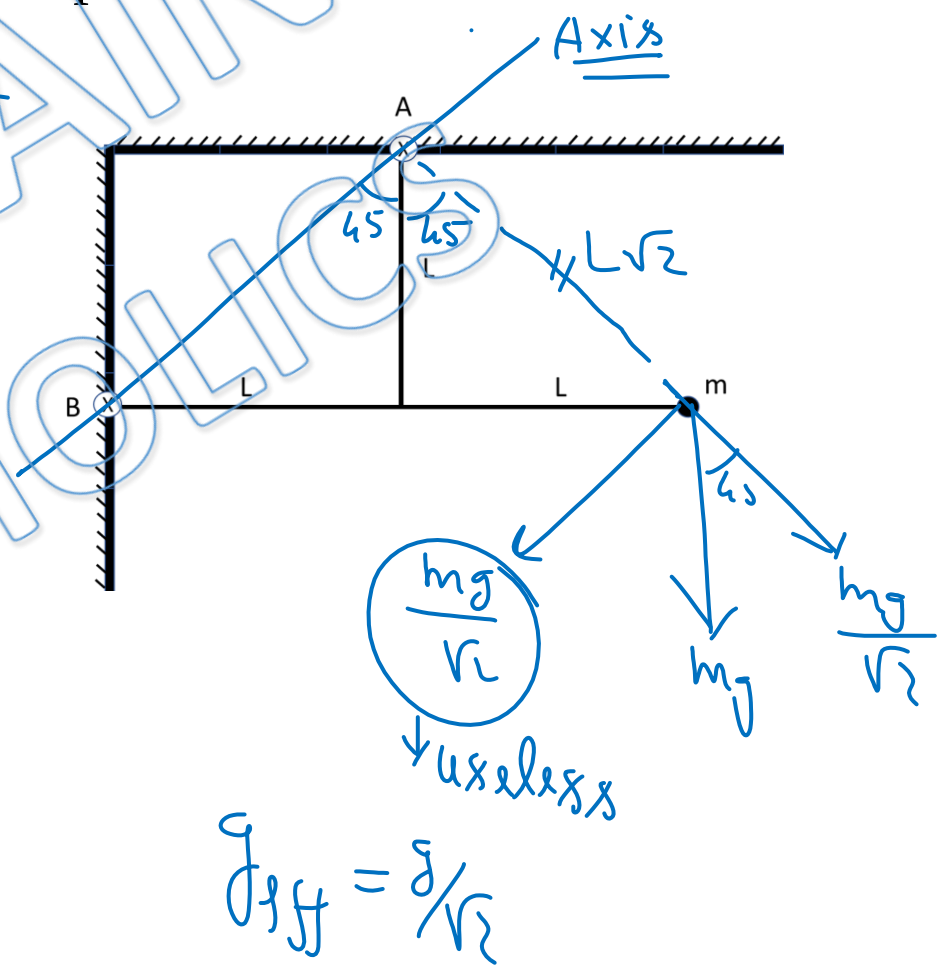
$$T = 2\pi\sqrt{\frac{m(L\sqrt{2})^2}{mg/\sqrt{2}\times(L\sqrt{2})}} = 2\pi\sqrt{\frac{2L}{g}}$$

(a) $2\pi\sqrt{\frac{L}{g}}$

(b) $2\pi\sqrt{\frac{2L}{g}}$

(c) $2\pi\sqrt{\frac{L}{2g}}$

(d) $2\pi\sqrt{\sqrt{2}\frac{L}{g}}$



$g_{eff} = g/\sqrt{2}$

Q8) A particle of mass m is attached with uniform rod of mass m and length L and system is floating in water as shown in figure. Now rod is slightly turned from vertical position and released. Find time period of angular shm of rod?

(a) $2\pi\sqrt{\frac{2L}{g}}$

(b) $2\pi\sqrt{\frac{6L}{5g}}$

(c) $2\pi\sqrt{\frac{L}{g}}$

(d) $2\pi\sqrt{\frac{5L}{6g}}$

Distance b/w COb & COM $= \frac{3L}{8} - \frac{L}{4} = \frac{L}{8}$

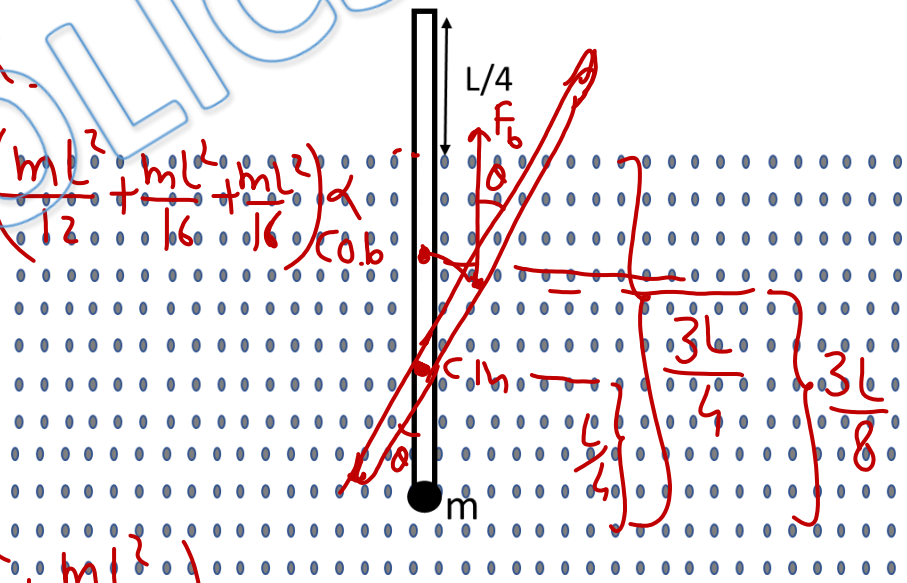
$F_b = 2mg$

$\tau_{cm} = I_{cm}\alpha$

$2mg \times \frac{L}{8}\sin\theta = \left(\frac{mL^2}{12} + \frac{mL^2}{16} + \frac{mL^2}{16}\right)\alpha$

$\frac{mgL}{4}\theta = \left(\frac{mL^2}{12} + \frac{mL^2}{16} + \frac{mL^2}{16}\right)\alpha$

$mg\times\theta = \frac{5mL^2}{6}\alpha \Rightarrow \alpha = \frac{6g}{5L}\theta$



Q9) A uniform rod of mass m and length ℓ suspended by two identical threads ℓ in length was turned through a small angle about the vertical axis passing through its middle point C. The threads deviated in the process through a small angle . Then the rod was released to start performing small oscillations. Time period of rod is

(a) $2\pi\sqrt{\frac{\ell}{4g}}$

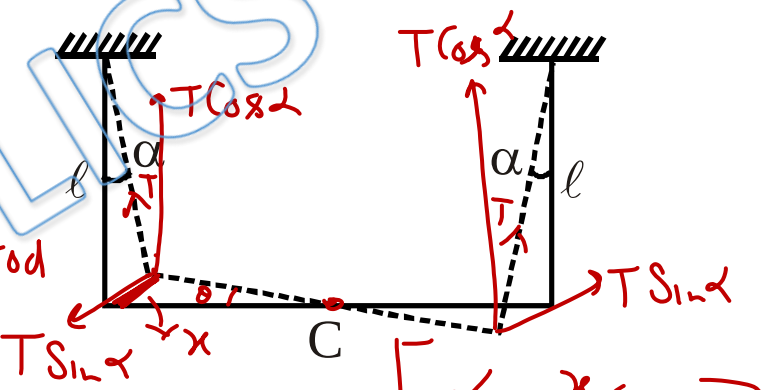
(b) $2\pi\sqrt{\frac{\ell}{3g}}$

(c) $2\pi\sqrt{\frac{2\ell}{3g}}$

(d) $2\pi\sqrt{\frac{4\ell}{3g}}$

$2T\cos\alpha = mg$

$T = \frac{mg}{2\cos\alpha} \simeq \frac{mg}{2}$



$\tau_c = I\alpha$ (α : ang acc of rod)

$T\sin\alpha \frac{\ell}{2} \times 2 = \frac{m\ell^2}{12}\alpha$

$\left[\alpha = x/\ell \quad \theta = \frac{x}{\ell/2} = \frac{2x}{\ell}\right]$

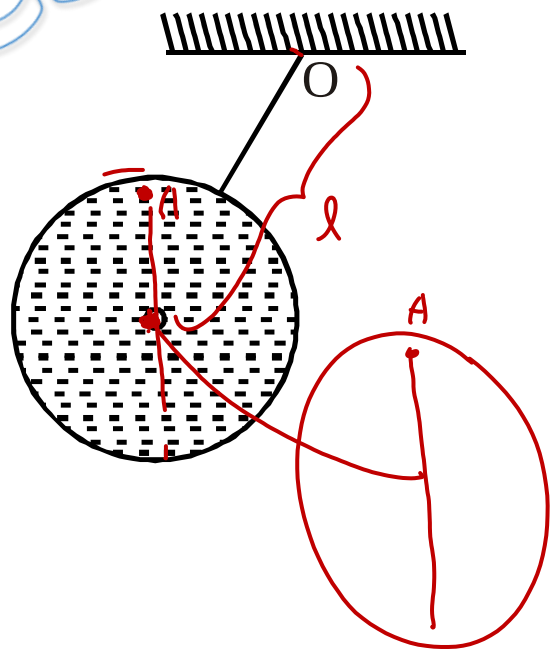
$\frac{mg}{2}\alpha\ell = \frac{m\ell^2}{12}\alpha$

$\frac{mg\ell\theta}{2\times 2} = \frac{m\ell^2}{12}\alpha$

$\alpha = \frac{3g}{\ell}\theta$

Q10) A pendulum is constructed as a light thin-walled sphere of radius R filled up with water and suspended at the point O from a light rigid rod. The distance between the point O and the centre of the sphere is equal to ℓ. How many times will the small oscillations of such a pendulum increase after the water freezes? The viscosity of water and the change of its volume on freezing are to be neglected. moves translation wise, and the system behaves as a mathematical pendulum.

In Case of liquid $T_1 = 2\pi\sqrt{\frac{\ell}{g}}$



(a) $\sqrt{1+\frac{1}{5}\left(\frac{R}{\ell}\right)^2}$

(b) $\sqrt{1+\frac{2}{5}\left(\frac{R}{\ell}\right)^2}$

(c) $\sqrt{1+\frac{2}{3}\left(\frac{R}{\ell}\right)^2}$

(d) 1

In Case of ice

$T_f = 2\pi\sqrt{\frac{I}{mg\ell}}$

$= 2\pi\sqrt{\frac{\frac{2}{5}mR^2+m\ell^2}{mg\ell}}$

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